ASSESSMENT OF NUTRITIONAL QUALITIES OF DRIED MEAT PRODUCTS

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DEDICATION

This project is dedicated to Almighty God, my late mother, Mrs. C.A. Akinbosoye and my dearest one, Miss. Folashade Idowu.

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My profound gratitude to God Almighty for his quidance throughout my programme.

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ABSTRACT

Test and Analysis were done according to standard procedures on four different samples of meat named raw mutton, raw beef, processed dried mutton product (Kilishi) and processed dried beef product (Kilishi). The test and analysis showed the differences and amount of the % crude protein, ash content, fat content, crude fibre, moisture content, reducing and non reducing sugar Ascorbic acid content and total volatile acid content of the samples.

The result showed that the crude protein content ranges from 13.35% - 40.50% in raw to dried meat product of mutton, 15.24% - 47.30% in raw to dried meat product of beef, the fat content of (1.50% - 15.50%) in mutton, (3.00% - 21.00%) in beef, the ash content of (0.66 - 9.00)% in mutton, (1.00 - 9.67)% in beef, the moisture content of (9.40-72.60)% in mutton, (9.00-61.00)% in beef, the crude fibre of (0.67-1.00)% in mutton and (1.00-1.33)% in beef. The reducing sugar content ranges form (0.2-0.4) 1^{u} moles/g/100ml. There is no traces of non-reducing Sugar and Ascorbic acid content of these samples showing that minute or no quantity of these nutritional components are available. The total volatile acid content of these samples variably exist and ranges from (o.24 - 0.28) g/100ml in mutton and (0.29 - 0.31) g/100ml in beef.

The proximate composition analysis in percentage showed that the nutritional qualities concentration are highly available at low moisture content in processed dried meat product than when the meat contain high moisture content. However, the processing of raw meat into dried meat product by drying, addition of additives and roasting has no negative effect on the nutritional qualities concentration of the meat, exception in the case where the meat is processed in unhygenic condition. As verified from the result dried meat products are very high in protein content i.e. have the highest percentage nutritive value than other nutritional qualities present.

From the result obtained, meat is not a reliable source of carbohydrate and vitamin C, and the amount of non volatile acid present is very small in quantity. Generally meat and dried meat products are good sources of protein and other nutritional contents most especially when processed in hygenic condition.

CHAPTER ONE

1.1 INTRODUCTION

Meat is the flesh of animals consumed for food. In the tropics, the bulk of meat consumed is mostly derived from sheep, cattle, goat, pigs, bush animals, poultry birds, domesticated animals or wild animals, reptilia animals and other sea foods. (Henrickson, 1978)

Meat is an excellent source of high quality B - complex vitamins and certain minerals especially Iron. It is easily digestible when cooked and supplies nutrients which contributes significantly to the dietary balance of meal. Meat is usually eaten in different forms, either as cooked meat, fried meat, roasted meat (suya) and also available in dried forms such as Kilishi (dry and roasted), Kundi (dry and smoked) and bush meat (dry and smoked). Though the processing may be different, they are all referred to as dried meat products.

Meat processed and preserved by drying are usually more readily available in the market than any other preserved form such at freezing and irradiation. Apart from its availability, dried meat products are consumed without further processing except if the buyer want it in soup mixes. It has been revealed form research that 100 gramme of processed beef will supply the required amount of protein needed by body of a day and that the same quantity could contain about 200 calories of energy apart from other nutrients such as vitamins, minerals, fats, water and sugar. (Gerard, 1971)

Meat products are also available in small quantity in some products like meatpies, chicken pies, vegetable or meat stew, sausage e.t.c. Therefore what could be considered as meat products should be purely, processed meat e.g corned beef, strained canned and dried meat products, that is when the meat has considerably low moisture

content "Kilishi", "Kundi" and bush meat (but not all) are typically dried meat products commonly found in Nigerian markets but their availability varied from State to State. For examples cow and goats thrive best in the Northern parts.

"Kilishi" are long thin slices of meat (0.17 ± 0.05cm thickness) locally processed from cow, goat and sheep carcass. It is commonly found in Nigerian market but peculiar to north and south and some parts in the eastern and western part of Nigeria. Kilishi is quite different from suya in that the roasting is done after sun drying thin long sliced meats already mixed with spices but in the case of suya the short thin sliced meat are roasted immediately after addition of spices. Meat processing generally involved a combination of mechanical action, addition of salt and other additives coupled with heat processing (Lewis, 1990).

"Kilishi" is usually processed from the hind quarters of either cattle, sheep and goat carcass. The carcass are usually reduced into strips to make it lighter in weight thus facilitating easy drying and processing. (Kramlich et al; 1973). As a ready meat product "Kilishi" appears to have an excellent shelf life stability at room temperature which makes handling and marketing very convenient for consumers and retailers alike (Igene et al; 1989). While, the handling and marketing of these dried meat products are easy, the assessment of the nutritional values is essential, so as to ascertain how much of these nutritive parameters are lost during drying process little or no work is done in this area, hence the need for this study.

1.2 JUSTIFICATION OF THE PROJECT

(i) There is little or no information on the nutritional qualities of Kilishi and other dried meat products locally processed in Nigeria

(ii) Kilishi and other dried meat products are regarded as major sources of protein in human nutrition and kilishi is more readily available in many of our markets in Nigeria hence it is desirable to conduct research into the assessment of its nutritional qualities.

(iii) Processing by drying and the use of additives is one of the major methods of preservation of meat in both rural and Urban areas. However its effects on dried meat products have not been verified extensively.

(iv) Due to lack of basic infrastructures such as portable water and electricity, meat processing is traditionally carried out in most of time in an unhygenic condition hence there is need to assess the locally processed dried meat so ascertain its quality.

1.3 OBJECTIVES OF THE PROJECT

(i) To determine the nutritional compsition or faw and dried meat product (Kilishi) of goat and cow meat

(ii) To know the differences in proximate composition and other nutritional qualities of dried meat products produced from goat and cow meat thereby comparing and assessing their nutritional qualities

(iii) To know the effects of drying processing (roasting or smoking) and additives on the nutritional qualities of meat

1.4 SCOPE OF THE PROJECT

Since we have different types of meat and dried meat products depending on the type of animal from which the meat is obtained, the scope of this project work is limited to assessment of most common dried meat product "kilishi" processed from cow (beef) and goat meat (mutton).

CHAPTER TWO

2.1 LITERATURE REVIEW

2.2 MEAT AND MEAT PRODUCTS

Meat can be considered as the flesh of muscle of cow, logs sheep, swine, goats and other animals used as human food. This can be generally considered as the edible portaion of the carcass of cattle, sheep, swine or horses. (U.S.D.A., 1976)

Meat is one of the most popular nutritions food of the human diet (swaninathan, 1979). It is easily digested and contributes enormonslsy to dietary balance of meal (price and schweigent, 1971). The different types of meat commonly consumed include beef from cattle, real from claves, hams, pork and bacon from hogs, mutton from sheep or goat and lamb from young sheep or goat. Meat cuts are composed of muscle, fat and bone and the proportion of which varies with age, diet of the animal and the part of carcass from which the animal cut is taken (Swaminathan, 1979)

Meat products are usually diversed ranging from those consisting of whole meat like pure ground beef Salami Suya and dried meat product "Kilishi" to those in which meat is only a minor element, such as meat pies, chicken pies and meat stew (Kramlich et - al, 1973). Therefore there are different views to what should and should not be considered as meat products. Meat products are considered as purely processed meat such as Suya, kilishi and kundi from either goat, sheep and cow meat. Other meat products may be from bush meat and domesticated animals but relatively suya, kundi and kilishi are the most common in our markets. With the exception of Suya, kilishi and kundi can be regarded as dried meat products because of their relatively low moisture content.

2.3 TECHNOLOGY OF FRESH MEAT PRODUCTION

The procedure of fresh meat production in the tropics is not standardised. After slaughter, usually by cutting the throat of the animal transversely or by decapitation (cutting off of the animal head), the animal is bleeding along the jugular vein of one side severed. The knife is then passed through the skin incision towards ht entrance of the chest, severing the anterior aorta and anterior vena cara, but in some cases of cattle, burned to remove hairs for smaller animals or scalded (burn with hot liquid) in pigs (Mitchell, 1980)

It is then eviscerated (cutting out the bowel) by opening the median line of the belly. This practice is a standard procedure in all meat processing operation (Mitchell, 1980)

2.4 CONVERSION OF MUSCLE TO MEAT

The conversion of muscle to meat or meat product could be viewed as a simple mechanical dis-intergration of the carcass after the animal is slaughtered. The numerous biochemical reaction governing the actions of muscle do not stop immediately after the animal is killed. At least cursory knowledge of most significant reactions occuring after slaughter is necessary to understand some of the basic steps in fresh and processed meat technology.

When a rested animal is killed, the glycogen in its muscle breaks down to lactic acid, it therefore means that an animal should be killed when its muscles contain the maximum concentration of glycogen in order that its meat may keep satisfactory (Mitchell, 1980). In living muscle, one of the most important reactions involving generation of energy needed for muscle contraction is glycolysis, glycogen is used up to generate the needed energy in the presence of oxygen thus.

glycogen $\xrightarrow{\text{enzymes}}$ glucose + O_2 $\xrightarrow{\text{enzymes}}$ $Co_2 + H_2$ of Energy

When oxygen is not available i.e after the animal is killed, or under stress (not rested) the glycogen and the resulting glucose are broken down to lactic acid but there is substancial drop in the P.H (Acidity) of the meat. At about 5.4, the fresh meat is well protected from microbial spoilage (Hillpress 1971). It is therefore necessary that proper degree of acidity is maintained to restrict bacterial growth during the meat storage hence this degree resulted form glycogen level in the animal before they are killed. The factors that are responsible. For glycogen level in the animals before they are killed should be noted, which are

i. The diet given to the animal

ii. The breed, age and sex of the animal

iii. The condition (health) of the animal before slaughtering

iv. The amount of inorganic phosphate present in the body of the animal

(Mitchell, 1980)

2.5 NUTRITIONAL CONTENTS OF MEAT AND MEAT PRODUCTS

Meat and meat products are generally excellent sources of protein, containing a good balance of essential amino acids, and a high nutritive valve. They provide excellent B - complex vitamins, minerals especially iron and also fat and water.

2.5.1 PROTEIN AND ESSENTIAL AMINO ACID

Meat is an excellent source of protein and essential amino acid with its contribution to the human dietary needs being recently reviewed by pellet and young, (1990). These authors concluded that the high content of dietary lysine in meat make the product particularly important in meeting the needs for this indispensable (essential)

amino acid in cereal based diets. Even though there is no absolute nutritional requirement for meat protein present in the human diet, meat is an excellent source of protein and indispensable amino that are highly palatable to humans (pellet and young, 1990)

The classic studies of Rose et al (1955) on the amino acid requirements of man showed that eight amino acids are essential in young adult males which are lysine, methionine, phenylalanine, threonine, tryptophan, valine and Isoleucine. Extersive studies on the essential and non essential amino acid components of fresh muscle and organ meats of cured and processed meats and of canned meats and meat products help to explain the high biological value of meat protein.

2.5.2 FATS AND ESSENTIAL FATTY ACID

Reiser and shorland (1990) have summarised some of the consideration about the relationship of meat fats and fatty acids to corronary disease (CHD), Animal fats are composed chiefly of neutral fats and phospholipids. The neutral fats are principally glycerol esters of straight chain carbonxylics acid or triglycerides. It was pointed out that not all long chain saturated fatty acids are atherogenic but may be metabolized differently than some shorter chain as recently confirmed by Bonanome and Grundy (1988). This does not mean that one should ignore the fat content of the diet but that the major mono unsaturated and saturated fatty acids found in meat may not increase the blood cholesterol but actually be anti-athrogenic in contrast to some of the shorter chain fatty acids (Bonanome and Grundy, 1988).

2.5.3 VITAMINS

The vitamins are usually divided into two groups on the basis of their solubility, i.e. the fat soluble vitamins (A,D,E and K) and the water soluble vitamins, which include vitamin C and group generally classified as the B - complex vitamins. Generally meat is not a good source of fat soluble vitamins A and E (Smith, 1990) but make little contribution to vitamin C intake and major contributors to B - Complex vitamin especially Thiamin, Riboflavin and Niacin intake.

2.5.4. MINERALS

The minerals required in the diet of human are generally classified into two groups, namely the macro and micro-minerals. Thus the differentiation is based on the relative amount needed by main with the former group required in larger amount than the latter. Meat are not good. Sources of calcium (except in debone product potassium or magnesium (Johnson and Welsen, 1990) but important dietary sources of phosphorus, sodium and chlorine especially in cured items where salt is used as one of the additives (Karanja et al; 1990)

2.5.5. MOISTURE CONTENT IN MEAT

The structure of the muscle and its substructure, especially the highly organised insoluble myotibrillar protein are responsible for the retension of (about 75%) water in muscular tissue. Water holding capacity or ability of meat depends on the method of handling and the state of the system. As the state of material and its treatment different considerably, the water holding capacity varies widely. It is therefore necessary to define the method of measurement adopted in order to obtain comparable results.

2.5.6. SUGAR CONTENT

Lactose is always the sugar of interest in meats. The analysis of other sugar such as dextrose, sucrose or maltose is rarely called for. A meal sample is analysed for its lactose content to determine the amount of non fat dry milk (NFDM) and calcium reduced dry skin milk (CRDSM). These two analytes are regulated for use as binders in certain cooked sausage products.

2.5.7. BROWNING REACTION

During heating of meat and meat products non-enzymatic browning reaction of the mallard type also contribute to colour changes. The browning of meat depends on the PH. An increase or decrease in PH from its normal level increases the intensity of brown colour formation on heating.

The addition of glucose or sucrose yield the same browning intensity in thermal processing. The temperature and duration of heating are very important for the extent of mallard reaction in meat. Mallard or non-enzymatic browning reaction between carboxyls in the smoke and free amino groups in the product influences colour development.

TABLE 1

Approximate composition of mammalian skeletal muscle (percentage fresh weight basis)

Components	Wet % weight
Water	75.00
Protein	19.00
Lipid	2.50
Carbohydrate	1.20
Miscellaneous	-
Non protein substances	2.30
(a) Nitrogenous	1.65
(b) Inorganic	0:65
Soluble phosphorus	0.20
Potassium	0.35
Sodium	0.05
Magnesium	0.02
Calcium, Zinc	0.23
Trace metal	-
Vitamins	-
Various fat and	-
Water soluble vitamins	-
Quantitatively minute	-

(Ngoddy and Ihekoronye, 1983)

TABLE 2

Nutritional Composition of beef, mutton and pork muscle per 100g

	Moisture (g)	**Protein** (g)	**Fat** (g)	**Mineral** (g)	**Energy** (g)
Beef	74.30	22.60	260	1.00	114
Mutton	71.50	18.50	1.33	1.30	114
Pork	77.40	18.70	4.40	1.00	114

(ICMR, 1984)

TABLE 3

Proximate Composition and Calorific content of typical processed meat

Meat products

BEEF BABY FOOD	Protein %	Water %	Fat %	Ash %	Carbon-hydrate %	Calories per 100g
Strained, Canned	14.70	80.30	4.00	1.00	0	99
Junior Canned	19.30	75.60	3.90	1.40	0	118
Corned beef hash	9.80	67.40	11.30	0.50	10.70	181
Dried, Chipper	34.30	47.70	6.30	11.60	0	203
Roast. canned	25.00	60.00	13.00	2.00	0	224
PORK						
Strained canned	15.40	77.70	5.80	1.10	0	118
Junior canned	18.60	74.30	6.00	1.30	0	134
Roasted entire	22.40	48.80	25.20	3.60	0	167
Salt pork	3.90	8.00	85.00	3.50	0	783
LAMB						
BABY FOOD						
Strained Canned	14.60	79.30	4.90	1.20	0	107
Junior canned	17.50	76.50	5.10	1.40	0	121

(0) Indicates amount too small to measure
(Kiernat et al, 1964)

TABLE 4

Typical mineral contents of types of meat mg/100g

Minerals	Beef	Pork	Lamb	Real
Ash	0.80	1.20	1.20	-
Calcium	11.00	9.00	10.00	11.00
Phosphorus	171.0	125.00	147.00	193.00
Iron	2.80	2.30	1.20	2.90
Sodium	65.00	7.00	75.00	90.00
Magnesium	18.00	18.00	15.00	15.00

(Watt and meril, 1963)

TABLE 5

Proximate Composition of lean muscle

Components	Net weight
H_20	75.00
Protein	19.00
Lipids (fats and oil)	2.50
Carbohydrate	1.20
Non protein	1.65
Mineral	0.65
vitamins	minute quantities

(Gracey and Collins, 1992)

TABLE 6

Thiamine, Riboflavin and Niacin content of raw meat

Types of meat **vitamins content (mg/100, meat)**

	Thiamine	Riboflavin	Niacin
Beef	0.06	0.13	3.60
Pork	0.76	0.18	4.10
Lamb	0.15	0.20	4.70
Veal	0.14	0.25	6.40

(Walf and meril, 1963)

TABLE 7

Summary of the amino acid composition of fresh beef, pork, lamb, cured and processed meat

Essential	Beef	Pork	Lamb	Cured and processed meat
Arginine	6.60	6.40	6.90	6.60
Hutidine	2.90	3.20	2.70	2.80
Isoleucine	5.10	4.90	4.80	4.90
Leucine	8.40	7 .50	7.60	7.40
Lysine	8.40	7.80	7.60	7.40
Methionine	2.30	2.50	2.30	2.20
Phenylalamine	4.00	4.10	3.90	4.00
Threonine	4.00	5.10	4.90	3.90
Tryptophan	1.10	1.40	1.30	1.00
Valine	5.70	5.00	5.00	5.20

(Schwcigert and payne, 1956)
All values are express in % crude protein (N x 6.25)

2.6 MEAT PROCESSING AND ITS IMPORTANCE

The origin of meat processing is lost in antiquity but probarbly began when primitive man first learnt that cooking prolongs the keeping quality of fresh meat. In case of meat processing, it had its origin by the dawn of Civilization. The ancient egyptian recorded the preservation of meat products by salting and dun drying. The early romans are credited with being the first to use ice and snow as a means of preserving food (forcest et al, 1975)

Modern food processing traces its, origin to the development of canning for which Nicholas. Appert, a chef received an official commendation from fresh government in 1809. Since that time advances in technology have continued to change processing methods (Kranlichet et al, 1973). Meat processing include all processes utilized in altering fresh meat. It includes canning, smoking, curing, cooking, freezing, dehydration, production of intermediate moisture products and the use of certain additives such as chemical and enzymes in meat processing plays a vital role in meat production in Nigeria and cannot be over looked.

Food generally has a social and nutritional functions in which flavour play a major part. The major flavouring used in meat is salt which performs the following functional

(i) It gives flavour to meat

(ii) It disguises objectivable intrinsic flavour

(iii) It retards microbial growth

(Ngoddy, 1985)

Furthermore, Spices such as piper guineense, melegueta pepper, Aframonium melegueta, Eugenia, carryophyllata, Dried pepper, Alliumcopa, capsicum Frustescene and others such as defatted groundnut cake powdered, maggi, salt, sugar, groundnut

oil, are grounded together to form dry ingredient which are use as additives in meat, and dried meat product processing. The use of spices is important in improving the appetite and consequently increasing the digestive power other functions are

(i) Enhancement of meat flavour

(ii) Flavour disguiser, 1.e they help mask off flavour of food which if unspiced small unplesant

(iii) Spices contain antioxidant properties while some act as preservative (manay and shara swammy, 1987)

The range of ingredients used in processed meat products are wide and include the basic materials, nitrogenous ingredient and the technical adjustment necessary to provide the properties which characterise the industrial products. The original basis for meat processing was pereservation by inhibiting or detering microbial organisms. Early meat processing was based on this concept (Hannan, 1974). In addition to preventing spoilage, preservation also resulted in flavouful and nutritions products. With the availability of refrigerators, meat processing has now taken on the additional aspect of providing both convenience and variety to meat portion of diet (kramlich et al, 1973).

Meat processing has resulted in major changes in the demand for certain cuts of meat. At the turn of this century, port was the only meat processed in large quantity. Today, beef and mutton are also used in large amount for the production of dried meat products including "Kilishi" (Laurie, 1979)

2.6.1 HEAT PROCESSING

Raw products are generally subjected to heat treatment after obtaining them from fresh carcass except for fresh product category. Heat processing include drying, cooking and smoking or roasting.

Heat process have the following effect on meat products.

(i) It reduces the moisture content of meat especially at the surface by evaporating water firm meat (drying). As a result the shelf life of the product is extended since microbial activities in presence of water have been hindered (Henrickson, 1978)

(ii) Action of heat on meat (cooking) coagulate the muscle fibre protein by reduction of hysine, methionine and tryprophan of protain and cause the meat to shrink as this modifies the texture of the meat.

(iii) It coagulates and denatures the meat by killing spoilage and toxigenic micro organism, altering their solubility and effecting change in colour

(iv) Heat processing improves the palability by intensifying the flavour and altering the texture (Henrickson, 1978)

SMOKING: It seems probable that normadic man first discovered the preservative action and the desirable flavour imparted to meat placed near the fire. Regardless of its origin, smoking has been proctised since the beginning of recorded. History long before the reasons for its effectiveness were understood (Ngoddy, 1985).

The smoking process may be carried out by conventional process of hanging of product in a smoke house in the presence of smoke for 4 - 8 hours at a temperature of 35°c-40°c or by holding for several hours in a room to which smoke is ducted from a smoke generator consisting of grinding wheel and a length of wood. In both cases the smoke is generated from cured hardwood such aspine. The smoking process has a

number of effects including a preservative effect brought about by the surface deposition of methanol, dimethyl propane , methamoic acid resin, waxes and many other materials. (Mann, 1960)

Deposition of phenolic compounds onto the surface of the meat prevent the product from rancidity (ill-smelling) and ensure long storage life. Smoking also imparts a great deal of the characteristic flavour on the traditional product.

DRYING: The process of sun drying of raw meat products has been practised for thousands of years by pastoral and normadic seeking simple means to preserve meat. A variety of traditional products have been developed that rely up on the interaction of preservative techniques involving (Henrickson, 1978)

(i) A restriction of water activity by drying

(ii) The use of Salt and Sugar to further control of water activity and to act as selective inhibitors of microbial and enzymes action.

(iii) The use of spices to further limit microbial development and to impart characteristics flavour

Drying is one of the process use in conjuction with additives addition in the preparation of "Kilishi" and it is usually carried out in two stages as it will be discuss under kilishi processing.

2.7 LOCAL PROCESSING OF KILISHI

A number of unit operations are involved which include preliminary operation like washing of the fresh beef or mutton carcass, cutting into smaller mass, further slicing and trimming into long thin strips usually of 0.17 ± 0.05 cm thickness and mixing with array of ingredients in a ratio 1: 1 and 1 : 4 during the first and second stage of drying (Igene et al 1989). The drying is in two stages, in the first stage the thin long

slices are sundried by hanging them on barbed wire or on a raised wooden bed covered with raffia matting at a ambient temperature of 30:3°c to 36°c and a relative humidity of 21% to 26% for 4 hours depending on the locality where the processing is carried out (Igene et al 1989). The dried Slices are later soaked in the slurry of ingredients for 1 hour with occasional turning as a result of which the dried meat took up the added ingredients at rate of 3g per gramme of the dried meats. (Igene et al 1989).

At the end of second stage of drying the thin slices are roasted over a glowing fire of locally made oven for 3 - 5 minutes to help fix the ingredients (Igene et al, 1989). Figure 1 shows the stages involved in preparation of "Kilishi"

TABLE 8

Composition of the mixture of ingredients used in "Kilishi" formulation prior to processing

Ingredients	Weight (g)	Proportion by weight mixture (g/kg)
Piper guineense	-	-
Eugenia Caryophyllata	-	-
Aframonium melegueta	50	11.70
Capsium frustescene	200	46.90
Dried pepper	200	46.90
Thonmigna Saguinea	10	2.30
Allium Cepa	500	117.30
Fagara Santhocyloides	10	2.30
Groundnut	25	4.90
Zingiber officinale (ginger)	100	23.50
Defatted groundnut	1500	352
Maggi	6	1.40
Salt	80	18.80
Sugar	80	18.40
Water	1500	352
TOTAL	4261	100

(Igene et al, 1989)

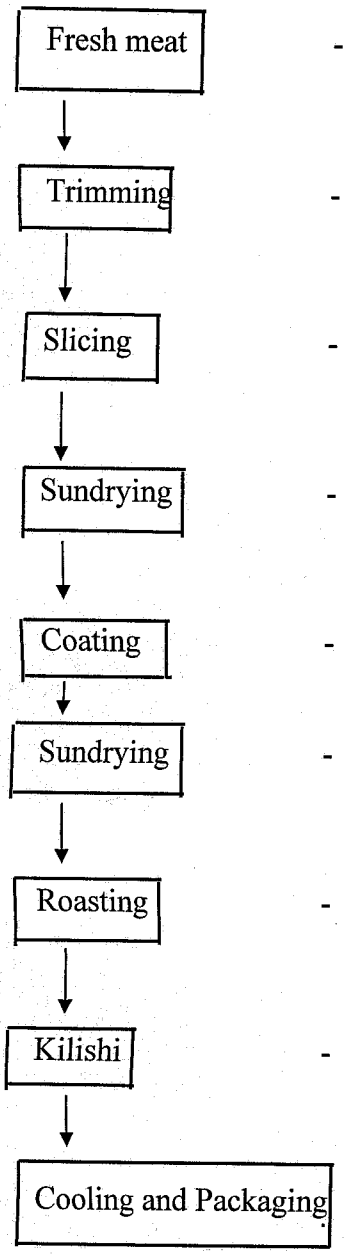

Figure 1: Flow chart of the operations involved in kilishi preparation

2.7. PRESERVATION

The susceptibility of preserved and restructured meat products to lipid oxidation has challenged meat technologists, processor and distributor to come up with techniques to extend the shelf life of these products (Gray et al, 1998). Preservation is a basic necessity of modern meat products distribution and storage and the development of the effective measures of preservation continue to be one major fields. The

preservation involves the application of measures to delay or prevent certain changes which make the products unstable or down grade some quality aspects of the products.

The pathway by which such deterioration can occur is not only lipid oxidation but can generally be gouped into microbial, chemical and physic processes. Most of the food preservation methods used today had their origin in prehistoric times. They have been refined and improved elaborated, placed on a scientific basis controlled and extended in application. The following are the ancient methods used.

(i). Drying including dehydration

(ii). Refrigeration including freezing

(iii). Heat treatment (cooking, roasting and smoking)

(v). Packaging

To these prehistoric method have been added three new processes

(i) Canning (ii) Controlled atmosphere storage irradiation.

On the other hand our traditional methods of food preservation are generally not very effective and do not tend themselves to large scale industrial products. For example, meat, fish and other perishable products are commonly preserved in Nigeria and other less developed country by drying in the sun. During the long period, chemical changes occur resulting in lower yield and deterioration in quality. In addition, the commodities may be exposed to insect, dust and other contaminants *(Aworh, 1987).*

CHAPTER THREE

3.1 MATERIAL AND METHODS

3.2 RAW MATERIAL AND SOURCES

About 1000g of raw goat meat and the same mass of cow meat samples were bought at mobil market in Minna, Niger State. The raw samples are transfered in different cellophone bag labelled A and B under ambient temperature to Yoruba road. Half of each sample was processed into kilishi, then allowed to cool for 1 hour before they are parked into different cellophone bag labelled C and D. The samples of kilishi and the remaining half raw meat samples were transported over a distance 3km under ambient temperature to biochemistry laboratory in Federal University of Technology Minna for test and analysis.

3.3 RAW MATERIAL PROCESSING AND STORAGE

The flow chart below shows the stages involved in the processing of raw samples of the meat into kilishi samples.

Fresh meat - (Obtained from goat or cow carcass)

↓

Trimming - (Cutting into smaller sizes with the use of knife)

↓

Slicing - (Cutting into, thin long slices using slicing knife)

↓

Sundrying - (Act of reducing the moisture content by direct sun heating)

↓

Coating - (Deeping into Slurry of mixture of ingredients on the meat)

↓

Sundrying - (Exposing to direct Sun heating to help fix the ingredients on meat)

↓

Roasting - (Cooking over a glowing fire for palatability and consumability)

↓

Kilishi - (Dried meat product)

↓

Cooling and Packaging (Act of making the final product available for consumers and retailers)

FLOW CHART SHOWING RAW MATERIAL PROCESSING

STORAGE

Prior to the commencement of the experiment the samples were left in the celophone bags under ambient temperature of 30°c - 36°c. The samples were labelled as follow:

Sample A - Raw goat meat sample (mutton)

Sample B - Raw cow meat sample (Beef)

Sample C - Processed dried goat meat sample (Kilishi)

Sample D - processed dried meat sample (Kilishi)

3.4. DETERMINATION OF PERCENTAGE PROXIMATE COMPOSITION OF RAW MEAT AND DRIED MEAT PRODUCT

The proximate composition of these samples were determined by Association of analytical chemist standard procedure (A.O.A.C., 1980) and Micro-kjeldah Nitrogen method.

3.4.1 DETERMINATION OF MOISTURE CONTENT (%)

The moisture content of the samples were determined by A.O.A.C., 1980. Accurate 3g of the samples A, B, C and D were weighed into different pre-weighed clean petri - dishes and the new weights of the samples plus the dishes were taken. The petri dishes were transfered into an oven maintained at 103 ± 2°c. After drying to a constant weight for 16 hours, the petri dishes and the contents were removed and cooled in a dessicator before reweighing the moisture content was calculated thus

$$\% \text{ moisture} = \frac{\text{mars of sample before drying (g)} - \text{mass of sample after drying (g)}}{\text{mass of sample (g)}} \times \frac{100}{1}$$

3. 4.2. DETERMINATION OF ASH CONTENT (%)

The ash content of the samples were determined by A.O.A.C, 1980 standard procedure. Washed and dried crucible was first cooled in a dessicator and weighed before 3g of oven dried of sample A ignited was weighed into an empty crucible and transfered into muffle furnace maintained at a temperature of 600°c for 6 hours and later cooled in a dessicator before the final grey product and the crucible was weighed. The same experiment was repeated for sample B, C and D and the ash content were determined thus % Ash content $= \frac{mass\ of\ ash\ crucible\ (g) - mass\ of\ crucible\ (g)}{mass\ of\ sample\ crucible - mass\ of\ crucible\ (g)} \times \frac{100}{1}$

3.4.3 DETERMINATION OF CRUDE FIBRE (%)

The crude fibres of the samples were determined by A.O.A.C., 1980 standard produce. The crude fibre of the sample were determined by first deffating 5g of each of the meat samples A,B,C and D. 3g of each defated sample was weighed into different 600ml beaker and 100ml TCA reagent was added. The solution were boiled and reflux for 40 minutes beginning form the time the boiling started. The flasks were removed cooled slightly and then filtered. The residues obtained from the filteration are washed 6 times with hot distilled and once with methylated spirit. The filter paper with each sample was transfered into porcelain crucible and dried in the oven at 100°c over might, they were then cooled in a dessicator and weighed.

The weighed samples were ashed in a muffle furnace at 500oc for 6 hours and finally cooled in a dessicator before reweighing. The loss in weight during incineration is equal to the amount of fibre which was calculated.

$$\% \text{ fibre content} = \frac{\text{Mass of insoluble matter (g) - masss of ash (g)}}{\text{mass of sample (g)}} \times \frac{100}{1}$$

3.4.4. DETERMINATION OF FAT CONTENT (%)

The fat content of the samples were determined by Association of Analytical chemist standard procedure (A.O.A.C., 1980). Washed and dried extraction flask was weighed and the soxhlet-extractor was fitted up with reflux condenser before putting on water flow via condenser.

5g of dried sample of a was introduced into a fat free extraction thimble plunged lightly with cotton wool, the thimble was then placed in the extraction barrel with the addition of $30cm^3$ of petroleum spirit (Boiling point 40^oc - 60^oc) and the sample was allowed to reflux for 6 hours, after 6 hours the thimble was removed and the flask containing the fat was dried in the oven at low temperature to evaporate the solvent completely before the flask with the fat was finally weighed. The same method was reperated for sample B, C and D. The percentage fat content was calculated as

$$\% \text{ fat content} = \frac{(\text{weight of flask} + \text{fat}) - (\text{weight of flask})}{\text{sample weight}} \times \frac{100}{1}$$

3.4.5. DETERMINATION OF CRUDE PROTEIN (%)

The protein contents of the samples were determined by kjeldah digestion and distillation Nitrogen method. 1g of minced sample of A,B, C and D were weighed into different digestion flask, 2 tablet of selenium as a catalyst was added to each sample to accelerate the digestion by increasing the boiling point of the samples and 10ml H_2SO4 was added to convert the Nitrogen present in the sample to ammonium hydrogen sulphate.

The digestion flask were fixed into the digester and put on for 5 hours. Until a clear solution of the samples were obtained. Each solution was cooled and transfered into different 100ml volumetric flask make up to mark with distilled water . After the distillation apparatus was rinsed for 10 minutes, 10ml of boric acid was measured into

4 different conical flask with 5 drops of indicator added to each of the 10ml of the digest. Sample A was measured into kjeldah distillation flask to which 10ml of 10% NAOH was added through the glass funnel ensuring that the distillation flask and the conical flask was in place. The solution of the boric acid and the indicator was timed until it turns green. This solution was then titrated with 0.IN hydrochloric acid the same was repeated for sample B, c and D and the percentage Nitrogen was calculated thus:

$$\% \text{ Total Nitrogen} = \frac{0.1401 \; x \; (\text{sample titre} - \text{Blank titre})_{(cm^3)} \; XN}{10 \; x \; \text{sample weight}_{(g)}} \; X \; \frac{100}{1}$$

Where N = Normality of the Acid

Therefore % protein (crude) = % Total Nitrogen X conversion factor

Conversion factor for meat =6.25

3.4.6. DETERMINATION OF TOTAL REDUCING AND NON REDUCING SUGAR (µ moles/g/100ml)

The simple reducing and non reducing sugar was determined using plumber method (1989) 0.2g of each sample was dried in an oven to a constant weight at 105°c, grounded to fine texture and dissolved in 100ml of water 1.2ml of each of the solution was pipetted into different test tubes labelled A, B, C and D. A standard solution was prepared using 0.09 g glucose + fructose (5mM - glucose and 5mM frutose) dissolved in 100ml distilled water. 0.2ml of the standard solution was pipetted into test tube labelled x 0.4ml into test tube Y and 0.6ml into Z.

2ml of DNS (Dinitrosalycite) reagent was added to each test tube X, Y and Z and also water to make up 4.5ml solution. The same was done to test tube A, B, C and D. Each solution was thoroughly mixed, heated in boiling water for exactly 15 minutes which were later cooled in a baker of water. The content of each test tube was made up to 20ml with thorough agitation, the test tubes were cooled to room temperature and estimation (absorbance) was read against 540nM Zeroing with test tube 1 the blank.

The amount of reducing sugar and non reducing sugar was obtained from the graph of absorbance of X, Y, Z against μ moles glucose + fructose in easy test tube as shown in TABLE 14.

3.4.7 DETERMINATION OF TOTAL VOLATILE ACID (G/100 ml)

The total volatile Acid of the samples were determined according to A.O.A.C 1980, standard procedure. O.2g of each grounded sample already dried in the oven was dissolved in 100ml of distilled water. 10ml of each of the solution was measured into different conical flask labelled A, B, C and D with the addition of 0.5ml phenolphthalein indicator and titrated against 0.IN NAOH until pink colour persisted for 15 seconds. 1ml 0.IN NaoH = 0.006g according to A.O.A.C., 1980.

The total volatile acid were calculated as follow

$$\text{VAC} = \frac{\textit{Titre x } N}{\textit{sample taken}} \text{ x } \frac{100}{1}$$

N = Normality of the base

The result is shown in TABLE 15

4.0 CHAPTER FOUR

4.1 RESULT AND DISCUSSION

4.2 RESULTS

Table 9 showed the result of moisture content determination using the air oven method. Four samples were used for determination and the result showed a variation of moisture content between 72.60% and 60.00 % for samples A and B and 9.00% to 9.40% for sample C and D.

Table 10 shows the ash content results which is between 0.60.% and 1.00% for samples A and B but 9.00% to 9.67% for samples C and D.

Table 11 shows the fibre content which is between 0.67% and 1.00% for samples A and B but 1.00%to 1.33% for samples C and D.

Table 12 shows the results of fat content determination which varied between 1.5% to 3.00% for samples A and B and 15.50% to 21.00% for sample C and D.

Table 13 shows the results of percentage protein content using micro K Jeldah nitrogen method. The results varied between 13.35% and 15.24% for samples A and B but 40.50% to 40.30% for sample C and D.

Table 13 shows the results of reducing and non sugar content which is 0.20 g/100ml for samples A and B and 0.6g/100ml to 0.80 g/100ml for sample C and D, while there is no trace of non reducing sugar.

Table 15 shows the total volatile acid content which is between 0.24g/100ml and 0.29g/100ml for samples A and B but 0.28g/100ml to 0.31g/100ml for sample C and D.

Table 16 shows the summary of the whole results obtained in table 9 to Table 15.

TABLE 9

MOISTURE CONTENT DETERMINATION (%)

SAMPLES

	A	B	C	D
Mass of petridish (g)	24.10	24.10	24.10	24.10
Mass of petridish + sample before drying (g)	29.10	29.10	29.10	29.10
Mass of petridish + sample after drying (g)	25.47	26.05	28.63	28.65
Mass of moisture (g)	5.00	5.00	5.00	5.00

$$\% \text{ Moisture} = \frac{mass\ before\ drying\ (g) - mass\ after\ drying\ (g)}{mass\ of\ sample\ (g)} \times \frac{100}{1}$$

$$\text{Sample A} = \frac{29.10 - 25.47}{5.00} \times \frac{100}{1} = 72.60\ \%$$

$$\text{Sample B} = \frac{29.10 - 26.05}{5.00} \times \frac{100}{1} = 61.00\ \%$$

$$\text{Sample C} = \frac{29.10 - 28.63}{5.00} \times \frac{100}{1} = 9.40\%$$

$$\text{Sample D} = \frac{29.10 - 28.65}{5.00} \times \frac{100}{1} = 9.00\%$$

TABLE 10

ASH CONTENT DETERMINATION (%)

SAMPLE

	A	B	C	D
Mass of empty Crucible (g)	7.53	7.53	7.53	7.53
Mass of sample (g)	3.00	3.00	3.00	3.00
Mass of Crucible + ash (g)	7.55	7.56	7.80	7.82
Mass of ash (g)	0.02	0.03	0.27	0.29

$$\% \text{ Ash} = \frac{mass\ of\ crucible + ash\ (g) - mass\ of\ empty\ crucible\ (g)}{sample\ weight\ (g)} \times \frac{100}{1}$$

$$\text{Sample A} = \frac{7.55 - 7.53}{3} \times \frac{100}{1} = 0.66\%$$

$$\text{Sample B} = \frac{7.56 - 7.53}{3} \times \frac{100}{1} = 1.00\%$$

$$\text{Sample C} = \frac{7.80 - 7.53}{3} \times \frac{100}{1} = 9.00\%$$

$$\text{Sample D} = \frac{7.82 - 7.53}{3} \times \frac{100}{1} = 9.67\%$$

TABLE 1D

CRUDE FIBRE DETERMINATION (%)

SAMPLES

	A	B	C	D
Mass of ashlet fitter paper (g)	7.53	7.53	7.53	7.53
Mass of fitter paper + insoluble matter before ashing (g)	7.56	7.58	7.69	7.72
Mass of insoluble matter (g)	0.03	0.05	0.16	0.19
Mass of ash (g)	0.01	0.02	0.13	0.15
Mass of Crude fibre (g)	0.02	0.03	0.03	0.04
Mass of sample (g)	3.00	3.00	3.00	3.00

$$\% \text{ Crude fibre} = \frac{crudefibre(g)}{sample(g)} \times \frac{100}{1}$$

Sample A $= \frac{0.02}{3} \times \frac{100}{1} = 0.67\%$

Sample B $= \frac{0.03}{3} \times \frac{100}{1} = 1.00\%$

Sample C $= \frac{0.03}{3} \times \frac{100}{1} = 1.00\%$

Sample D $= \frac{0.04}{3} \times \frac{100}{1} = 1.33\%$

TABLE 12

FAT CONTENT DETERMINATION (%)

SAMPLES

	A	B	C	D
Mass of empty flask (g)	59.64	59.64	59.64	59.64
Mass of flask + fat (g)	59.67	59.70	59.95	60.06
Mass of fat (g)	0.03	0.06	0.31	0.42
Mass of sample (g)	2.00	2.00	2.00	2.00

$$\% \text{ Fat} = \frac{weight\ of\ flask + fat\ (g) - (weight\ of\ empty\ flask\ (g)}{sample\ weight(g)}$$

$$\text{Sample A} = \frac{59.67 - 59.64}{2.00} \times \frac{100}{1} = 1.50\%$$

$$\text{Sample B} = \frac{59.70 - 59.64}{2.00} \times \frac{100}{1} = 3.00\%$$

$$\text{Sample C} = \frac{59.95 - 59.64}{2.00} \times \frac{100}{1} = 15.50\%$$

$$\text{Sample D} = \frac{60.06 - 59.64}{2} \times \frac{100}{1} = 21.00\%$$

TABLE 13

CRUDE PROTEIN DETERMINATION (%)

SAMPLES

	A	B	C	D
Mass of sample digested (g)	1.00	1.00	1.00	1.00
Titre Value Final volume (cm^3)	15.25	17.40	46.25	54.02
Initial volume (cm^3)	0.00	0.00	0.00	0.00
Titre (cm^3) value	15.25	17.40	46.25	54.02
Dilute of digest used (cm^3)	100.00	100.00	100.00	100.00
Volume of digest use (cm^3)	10	10.00	10.00	10.00

$$\% \text{ Total Nitrogen} = \frac{0.01401 \times \text{Titre } (cm^3) \text{ XN}}{10 \times \text{Sample weight(g)}} \times \frac{100}{1}$$

% Crude protein = % total nitrogen x conversion factor
Normality of acid use = 0.1 Nhcl
Conversion factor = 6.25 for meat
Volume of digest use = 10.00 cm^3

$$\% \text{ Total nitrogen} = \frac{0.1401 \times 15.25 \times 0.1}{10 \times 1.00} \times \frac{100}{1}$$

$$= 2.14\%$$

% Crude protein = 2.14 x 6.25 = 13.35%

$$\text{Sample B} = \frac{0.140 \times 17.40 \times 0.1}{10 \times 1.00} \times \frac{100}{1} = 2.43\%$$

% Crude protein = 2.43% x 6.25 = 15.24%

$$\text{Sample C} = \frac{0.140 \times 46.25 \times 0.1}{10 \times 1.00} \times \frac{100}{} = 6.48\%$$

% Crude protein = 6.48% x 6.25 = 40.50%

$$\text{Sample D} = \frac{0.140 \times 54.02 \times 0.1}{10 \times 1.00} \times \frac{100}{1} = 7.57\%$$

% Crude Protein = 7.57% x 6.25 = 47.30%

TABLE 14

REDUCING AND NON REDUCING SUGAR DETERMINATION

µ moles/g/100ml

	Standards				Unknowns			
Tube Number	1 Blank	2 X	3 Y	4 Z	5 A	6 B	7 C	8 D
5mM glucose 1mM fructose	0.0	0.4	0.8	1.2	0.0	0.0	0.0	0.0
µ moles sugar present	0.0	2µ moles Glucose 2µ moles Fructose	4µ moles Glucose 4µ moles Fructose	6µ moles Glucose 6µmoles Fructose	0.20	0.20	0.60	0.80
Samples Solution	0.0	0.0	0.0	0.0	1.2	1.2	1.2	1.2
Water	2.5	2.1	1.7	1.3	1.3	1.3	1.3	1.3
DNS	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
∑el reading	0.00	0.11	0.24	0.32	0.01	0.01	0.03	0.04

The micro moles of sugar (reducing) of the samples are calculated from the graph of ∑el or spectronic reading (absorbance) plotted against µ moles glucose and fructose in standard solution (concentration).

4cm represent 2 unit on x axis

4 cm represent o.1 unit on Y axis

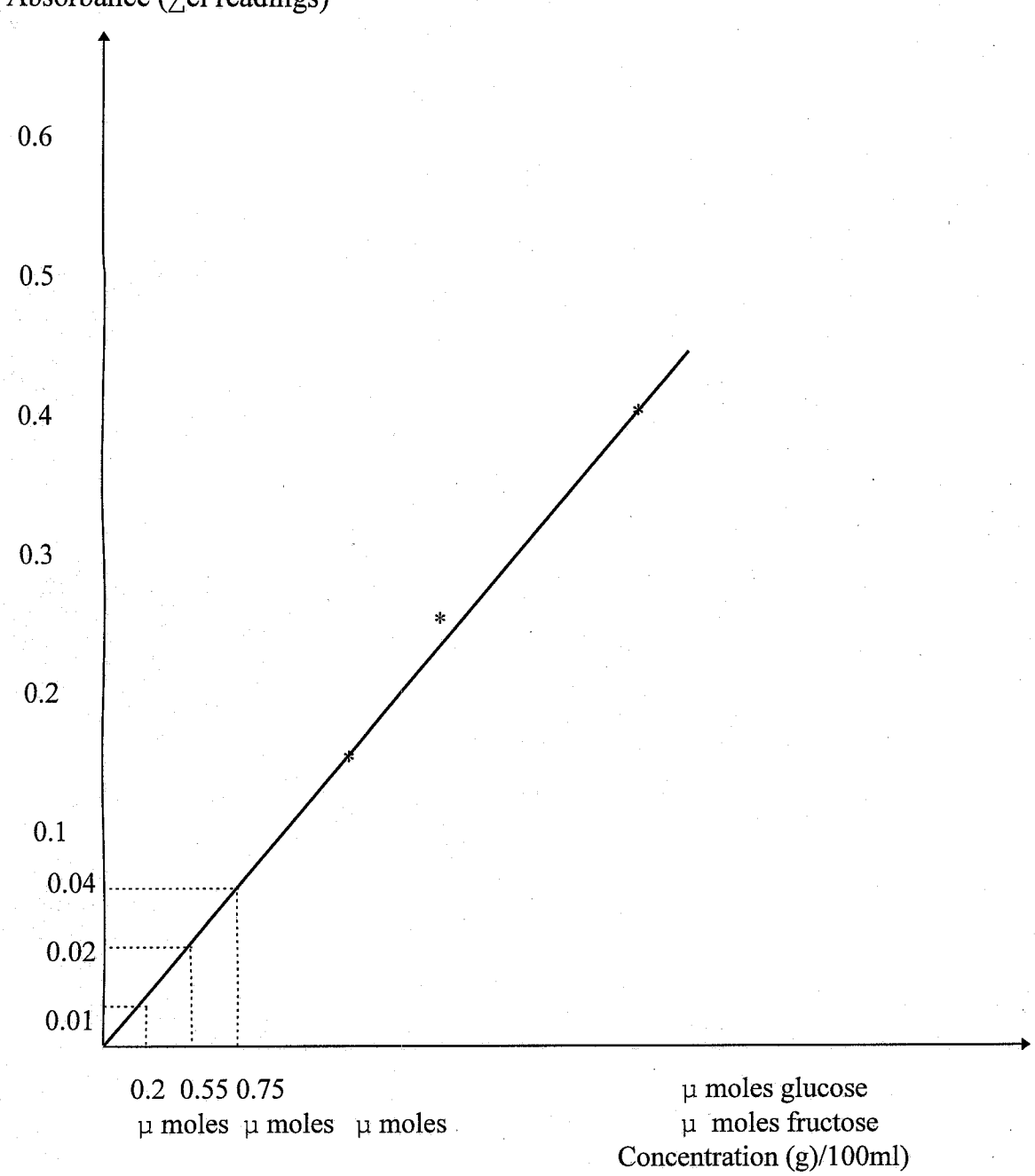

TABLE 15

DETERMINATION OF TOTAL VOLATILE ACIDITY (g/100ml)

Sample	Initial burette reading (cm^3)	Final burette reading (cm^3)	Titre value (cm^3)	Sample taken (ml)	Total volatile Acid (g/100ml)
A	0.00	0.40	0.40	10	0.24
B	0.00	0.48	0.48	10	0.29
C	0.00	0.46	0.46	10	0.28
D	0.00	0.50	0.50	10	0.31

1ml 0.1N Naoh = 0.006g according to A.O.A.C (1980)

$$\text{Total volatile Acid} = \frac{Titre \times N}{sample} \times \frac{100}{1}$$

Where N = Normality of the base

$$\text{Sample A} = \frac{0.40 \times 0.006}{10} \times \frac{100}{1} = 0.24\text{g/100ml}$$

$$\text{Sample B} = \frac{0.48 \times 0.006}{10} \times \frac{100}{1} = 0.29\text{ g/100ml}$$

$$\text{Sample C} = \frac{0.46 \times 0.006}{10} \times \frac{100}{1} = 0.28\text{g/100ml}$$

$$\text{Sample D} = \frac{0.52 \times 0.006}{10} \times \frac{100}{1} = 0.31\text{g/100ml}$$

TABLE 16:PROXIMATE COMPOSITION OF RAW MEAT AND DRIED MEAT PRODUCT (g/100g), TOTAL VOLATILE ACID (g/100g) REDUCING AND NON REDUCING SUGAR (μ MOLES / g/100ML)

MEAT SAMPLE	MOISTURE CONTENT	ASH CONTENT	CRUDE FIBRE	FAT CONTENT	CRUDE PROTEIN	REDUCING SUGAR	NON REDUCING SUGAR	TOTAL VOLATILE ACID
SAMPLE A	72.60	0.66	0.67	1.50	13.35	0.20	N.T	0.24
SAMPLE B	61.00	1.00	1.00	3.00	15.24	0.20	N.T	0.29
SAMPLE C	9.40	9.00	1.00	15.50	40.50	0.60	N.T	0.28
SAMPLE D	9.00	9.67	1.33	21.00	47.30	0.80	N.T	0.31

N.T — NO TRACES

SAMPLE A - Raw goat meat Sample
SAMPLE B - Raw cow meat Sample
SAMPLE C - processed dried goat meat Sample
SAMPLE D - processed dried cow meat Sample

4.3 DISCUSSION

From table 9 results, it was observed that there was reduction in moisture content of raw meat to kilishi from 72.60% to 9.00% for sample A and C and 60.00% to 9.40% for sample B and D due to evaporation of water during drying process.

The moisture content reduction has numerous advantages in dried meat product, apart from increase the concentration of the nutrient in the remaining mass of dried meat product, it also have a preservative effect. The reduction of moisture content by drying to cintrol water activity, the use of salt (curing agent) and sugar act as selective inhibitors to microbial growth and enzymatic action. The use of nitrite salt stabilises the meat colour while the other ingredients such as dry peper, frustescene, allium cepa, magara, el cetra. And roasting goves a desirable meat flavour and help in colour stabilisation as well. All these factors increases the palatability and shelf life of the meat product.

From table 10,. The ash content increases from 1.00% in fresh meat cut to 9.67% in dried meat product due to increase in the mineral content as a result of ingredient addition, e.g. salt and capsicum frustescene. The ash content accurately reflects the mineral contents but does not differentiate between the minerals. Aside from the minerals added as curing agents, the mineral content of the muscle is constant. Meat products are good sources of calcium, potassium, magnessiun, phosphorus and chlorine (macro minerals), (Johnson and Nielsen, 1990), but are poor sources of micro minerals except in the improvement of manganese balance of human nutrition.

From table 11, the percentage crude fibre of the meat varies from 1.00% to 1.33% in kilishi, indicating that the amount of indigestible matter in the product is very small due to high digestibility of protein been incraesed due to subjection of the meat to moderate cooking (roasting) and reduction in the product moisture content.

From table 12, it was observed that processed dried meat product are high in fat content (about 15.0% to 21.0%) and this characterised for their high energy values in human nutrition. Meat products are highly desired for their distinctive and highly priced flavour.

Raw meat is generally known as being salty (inorganic salt present), metallic and "bloody" tasting with sweet aroma (wasserman, 1972). During cooking numarous aroma associated with beef, pork and so on are usually occured due to lipid oxidation and maillard reaction (non enzymatic reaction between sugar and amino acid) but almost 90% of the flavours and odours of meat arise as a result of lipid reaction while 10% comes from maillard raection and thiamin degradation.

The development of oxidative rancidity has long been recognised as a problem of meat storage shelf life apart from hydrolytic rancidity (lipids subjected to hydrolysis) which result in off flavour. The propensity of meat and meat product to under go oxidative depends on several factors including fatty acid compostion and presence of pro-oxidant in the muscle.

Meanwhile the suscepbility of muscle lipid to oxidation depend on their degree of unsaturation. The poly-unsaturated fatty acid content of muscle varies between species and decrease in the order: fish > poultry > pork > beef > mutton (Allen and

foegeeling, 1981).

Conversely, the resistance or prevention of meat lipid oxidation by using anti-oxidant such as vitamine E (as available in groundnut and ginger used as part of kilishi ingredients) functions as a free radical chain scavengers to effectively break free radical chain mechanism occuring during lipid oxidation (monohan et al, 1992). Apart from above mentioned factor,s the processing conditions such as reduction in meat particle size, cooking and various additives used in formulation eg. Salt, nitrite, phosphate, extenders or fillers also enhances oxidative rancidity (Gray and Pearson, 1987).

From table 13, it was observed that, meat product when dried and processed at relatively low temperature have high percentage of protein than in fresh meat cuts. The method employed in commercial production of kilishi does affect the nutritional values of meat protein and no statistically significant loss of amino acid occurs as a result of standard cooking procedure.

The drying and processing of meats have been reported to have variable effect on meat protein, such as increasing its digestibility (price and shweigert, 1971). The decrease and moistuer content and PH as a result of drying at low temperature causes precipitation of essential amino acid such as lysine, tryptophan and methionine from solution does increasing the efective volume of protein. Increase in the rate of diffusion, crystability, electrophoteric as in protein chemistry.

The addition of ingredients like defated ground nut characterised with high protein content also increases the protein content of dried meat product. The effect

of salt soluble protein are also increase by salt addition which provide cohensiveness of meat particles in finished porduct such as in kilishi.

From table 14, the small percentage of reducing sugar (0.20 g/100ml to 0.80g/100ml in kilishi) and zero traces of non reducing sugar indicate that meat is a poor source of cabonhydrate. The increment of the reducing from raw meat to kilishi is an indication the sugar added during the process.

From table 15, it aws observed that the total volatile acid ranges from 0.24g/100ml to 0.28g/100ml in kilishi. The total volatile acid indicate the amount of acid which can escape in to atmosphere during processing. This is an important factor in processed meat storage shelf life. The PH of 5.8 is needed in meat or meat product to produce an open structure which encourages the rapid and complete penetration of salt into the tissue.

This also help in control of mirobial development on both the surfaces of the product and in deep tissue where an anaerobic spoilage bacteria have a slow growth only if the PH is below 5.6.

Generally, processing of meat by drying, use of ingredient and heat treatment (roasting) increase the nutritional qualities of meat.

5.0 CHAPTER FIVE

5.1 CONCLUSION AND RECOMMENDATION

5.2 CONCLUSION

The results of percentage proximate composition, sugar and total volatile acid in ran eat and kilishi showed that the nutritional qualities of the meat are not affected by drying stead, it makes them readily available in higher concentration as a result of lowering the oisture content thus extending the storage shelf life of the meat by hindering the microbial tivities growth which usually takes place in the presence of high moisture content.

The use of spices and other ingredients stabilizes the colour, increased its palatability, mineral content (use of salt and maggi) and its protein and fat content (use of defated oundnut). The roasting of the meat increases its digestibility and thus reducing non gestible material (crude fibre). Meat has low reducing sugar therefore making it a poor urce of carbohydrate.

When the results obtained was compared to previous studies on proximate mposition of typical processed meat product such as strained canned, dried chipper, corned ef ash e.t.c. It was observed that protein is the most available nutrient in meat and meat oducts and the meats differs in composition in different animals depending on the breed, age, x, anatomical location and diet of the animal during growth.

3 RECOMMENDATION

I. Because of high protein content and other nutritional qualities present in dried at product such as kilishi and it readily availability for consumption, effort should be made how to process the product in hiegenic way and condition to retain its high percentage

utritional qualities concentration unaffected thus increasing for its demand.

II. Low and moderate heat should be use in roasting of the meat, as over heating o have negative effect on the amino acid thus affecting the protein content, its digestibility nd inturn its storage shelf life.

III. Further work should be done on other nutritional qualities not mentioned in is project, such as nitrite content, cholesteron and mould count because of their importance in eat safety.

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